

PCEFIS Electronic Attitude Reference System

Inertial Measurement Unit (IMU) Model no. EFIS-AIGYRO6X
Software Model no. EFIS-AISW3
Version 3.6b

USER'S GUIDE

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CAUTION

The Electronic Attitude Reference system is not an FAA TSO'd aircraft instrument. It is intended solely for use as an auxiliary attitude display for use in VFR flight conditions and should never be used as an IFR flight instrument. Any single attitude display device can fail, be misused and/or misinterpreted, and therefore become unsafe. Use the attitude reference system at your own risk. To reduce the risk carefully review and understand all aspects of this user manual and always use external visual horizon contact for flight attitude control. The electronic attitude reference system is not intended to be used as the primary flight attitude indicator and must never be used as such. Never rely on any single attitude display instrument for attitude control of any aircraft. Violation of this principle virtually ensures that aircraft control will eventually be lost and that an accident will occur.

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REGULATORY COMPLIANCE

The attitude reference system is not an FAA approved device. It must be used as a portable device, not permanently connected the aircraft.

This equipment has been tested and found to comply with the limits for a Class B digital device pursuant to Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio or television reception, which can be determined by turning the device off and on, you are encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between this equipment and the receiver.
- Connect the equipment to a power source on a different power bus than that of the receiver.
- Consult the dealer or an experienced radio/TV technician for help.

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INTRODUCTION

The attitude reference system uses precision inertial navigation system (INS) technology similar to that used in the newest commercial airliners and many spacecraft. The system uses a technique called strapdown inertial navigation (strapdown INS). This implies that the sensing system is "strapped down" to the airframe and is then able to sense the accelerations and rotations of the airframe to determine the aircraft attitude. The attitude reference system consists of an inertial measurement unit (IMU) module, and an attitude processing/display computer. The technology used for the attitude sensor module (IMU) is the same as that used in attitude heading reference sensor (AHRS) devices. In order for the system to work properly it is imperative that the IMU module be properly installed in the aircraft.

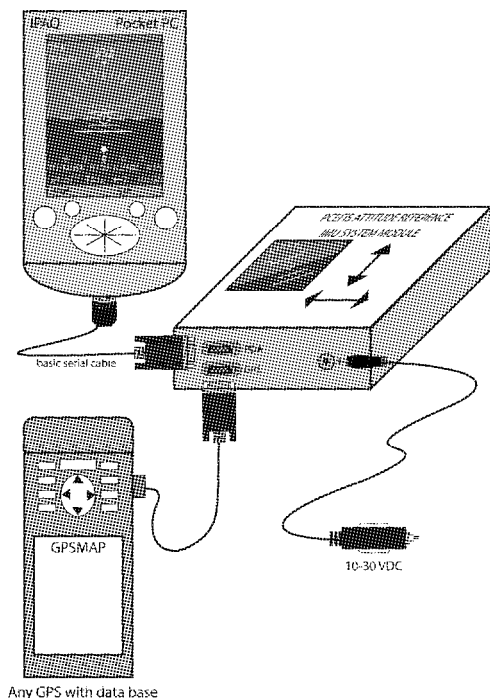
Until the 1990's most aircraft attitude systems utilized mechanical gimballed gyroscopes. During the 1990's commercial airliners and corporate jet aircraft began using "strap down" INS systems which utilized solid-state fiber-optic or solid-state electronic gyroscopes in conjunction with accelerometers and micro-computers to perform the required attitude derivation calculations. These strap down INS systems typically cost over \$100,000. The recent advent of micro-electromechanical system (MEMS) devices has enabled the development of miniature solid-state accelerometers and solid-state gyroscopes. These new MEMS components can be used in conjunction with personal computer technology to provide strap-down INS systems at a cost of well under \$10,000.

The PCFLIGHTSYSTEMS Attitude Reference System consists of a strapdown INS sensor module (the IMU) and a software package for use with handheld computers, such as the Compaq iPAQ 3600, 3700, or 3800 series (typically called Personal Data Assistants - or PDA's). The PCFLIGHTSYSTEMS IMU uses electronic gyroscopes. These are solid state devices which use silicon elements that utilize the Coriolis effect to determine angular acceleration rates. The PCFLIGHTSYSTEMS IMU uses MEMS accelerometers to detect the acceleration on the aircraft and also to assist in the determina-

tion of the aircraft attitude. The PCFLIGHTSYSTEMS IMU contains three of these solid-state electronic gyroscopes, solid-state accelerometers, and a micro-controller system. The gyroscopes sense the rate of rotation of the aircraft around the roll, pitch, and yaw axis. The accelerometers sense the acceleration of the aircraft around the roll, pitch and yaw axis and also sense the aircraft orientation relative to the earth. Three gyroscopes are required to accurately determine aircraft attitude in a strap-down INS. This is required because the aircraft attitude determination requires yaw angular sensing whenever the aircraft is not in a straight and level attitude. Accurate aircraft attitude determination requires that roll, pitch and yaw all be measured. This requires a dedicated gyroscope for each of the roll, pitch and yaw axis. The micro-controller system converts the gyroscope and accelerometer signals into digital signals. These digital signals are then processed using digital signal processing algorithms. The processed data is then sent over a serial communication cable to the PDA. The software package in the PDA then further processes the sensor data and converts it into a data display format. The data is then displayed as an attitude/horizon gyro display in the same format as the Electronic Flight Information Systems (EFIS) used in commercial airliners.

The recommended pocket computer is the Compaq iPAQ H3600, H3700, and H3800 series computer. The best source of iPAQs is directly from the Compaq website at www.compaq.com. A serial adapter cable is required to connect the iPAQ to the gyro module. The recommended serial cable for the iPAQ H3600 series PDA's is the "Serial Autosync Cable" Compaq part number 191008-B21. The serial cable and adapter cables can be purchased directly from the Compaq website at www.compaq.com. Compaq also provides a cigarette lighter power adapter which is the "Auto Adapter Kit" part number 180743-B21. This adapter is recommended to power the iPAQ to preserve the iPAQ batteries as an emergency power source. PCFLIGHTSYSTEMS provides a custom interface cable that provides data and power to the iPAQ via a single connection to the gyro module. The PCFLIGHTSYSTEMS iPAQ interface option contains this combined power/data cable.

INERTIAL MEASUREMENT UNIT (IMU) MODULE INSTALLATION



The IMU module must be securely mounted in the aircraft. The optimum location of the IMU module is near the aircraft center of rotation. The recommended mounting location for low wing aircraft is on the floor of the cabin area near the center of the main wing spar. For high wing aircraft the best location is as close as possible to the fuselage center line. Any other location within about 6 feet of the main wing spar will work acceptably. The PDA display computer can be located at any convenient location. The PDA is not sensitive to any vibrations or movements during flight. All motion sensing is performed by the IMU module.

The IMU module senses the accelerations and roll rates of the aircraft yaw, pitch and roll axis. To ensure good accuracy, it is imper-

ative that the IMU module be mounted so that it does not vibrate or move from its mounted location during flight. The IMU module works by detecting the aircraft roll rates and accelerations. If the IMU module vibrates, or is not mounted securely, the vibrations and movements will be interpreted as false acceleration and roll inputs by the IMU system. This will cause errors in the calculated and displayed attitudes. The errors will be a direct function of the level of vibration and movement of the IMU mounting.

The IMU module is enclosed in a vibration absorbing case. Velcro strips are attached to the bottom of this case. This mounting technique has been used successfully even in aircraft such as Piper Cubs, which have high levels of airframe vibration and interior noise levels.

The preferred mounting technique is to use the supplied Velcro strips. Four 1" by 1" squares can be cut from the supplied velcro pieces and attached to the aircraft to mate with the corner areas of the velcro on the gyro module. It is not necessary to use the full velcro mounting surface. The Velcro strips have an adhesive backing that allows them to be attached to a clean aircraft surface. The supplied Velcro is a type of Velcro which can attach to itself, that is, both mating pieces of Velcro are of the same type, instead of the older style of Velcro which used a plastic hook piece in conjunction with a fabric piece. For installation on a carpeted surface, it may be desirable to firmly attach the Velcro fasteners to the carpet by hand stitching with heavy sewing thread, in addition to the adhesive. Small bungee cords or elastic straps can also be used to mount the unit to the aircraft.

A variety of "clamp on" type holders (such as the R-A-M mounts made by National Products Inc. (206)763-8361 www.ram-mount.com) can be used to provide a mounting surface. The Velcro can then be used to mount the IMU module to the clamping device.

The most important factors for the mounting of the IMU module are:

1. Module must not vibrate.
2. Module must not move on the mount.
3. Module must be aligned with axis of flight.
4. Module should be as close as possible to center of aircraft rotation.

Vibration and mounting movement of the IMU module will cause inaccurate attitude displays.

Your iPAQ must be connected to the IMU (gyro module) using one of three methods.

The IMU module should be connected to the computer display unit using a serial interface cable. (RS232 serial cable) These cables are available from the PDA manufacturers. Extension cables can also be used to enable the PDA to be located up to 20 feet from the IMU module. The PDA should be connected to the TOP DB-9 connector of the gyro module. The BOTTOM DB-9 connector is used to connect to a GPS data input source.

Install a fresh 9 Volt alkaline battery into the IMU unit. The IMU can also be powered using an external power source (8 to 32 volts DC). An optional power adapter is available which can be plugged into a cigarette lighter power outlet.

A 9 Volt alkaline battery should be kept in the IMU even with an external power supply. The IMU will not drain the battery when connected to an external power supply. The IMU is designed to automatically switch to the internal battery in the event of a failure of the external power source. It is recommended that the gyro module be powered by an external power source to ensure that the battery does not discharge. There is no manual "on/off" switch on the gyro module. The gyro module will be on whenever external power is applied. The internal battery will only be used when the PDA software is running when external power is not supplied to the gyro. When the PDA software is running and no external power is supplied to the gyro module, the battery will be powering the gyro module. The amount of time the battery can power the gyro module depends on the quality and age of the battery. A fresh alkaline 9 Volt battery of high quality (Duracell or better) will typically power the gyro module for over 5 hours.

One of the most common problems encountered by customers is the inability to accurately mount the unit in a level position. We originally designed the algorithm to be very accurate in all pitch and roll attitudes. The problem with this was that it required the unit be mounted to better than two degrees of true level when the

aircraft was in straight and level flight. Because of our desire to make the unit truly portable, it became necessary to modify the algorithm to work well even if the unit is not accurately mounted (allow as much as 10 degrees of mounting error). To meet this requirement we have optimized the algorithm to accurately display when the aircraft is in a level attitude. The trade-off is that the actual bank angles in turns are no longer as accurate as they were previously, but straight and level is now very precise. We believe this is the appropriate compromise. A primary goal of the current product is to perform as an emergency horizon in the event the primary flight display of the aircraft fails. To accomplish this goal we have optimized the pitch and roll display algorithm to be accurate when the aircraft is in a near level attitude with a tradeoff of less accuracy when the aircraft is in a steep bank configuration.

SOFTWARE INSTALLATION

Note: The PCFLIGHTSYSTEMS complete system packages with iPAQ will already have the software pre-installed on the iPAQ, so you will not have to use the following procedure to install the software. In the event you need to re-install the software then the following procedure should be used.

The display software module is named PPCEFIS.EXE. This software must be installed onto a hand held computer (personal data assistant - PDA). The handheld computer must contain the Microsoft PocketPC operating system.

The PPCEFIS software is provided on a 3.5 inch floppy diskette. This software must be installed onto the PDA using a personal computer. The PDA manufacturer supplies an interface which enables software to be loaded onto the PDA from a personal computer. The most widely used software for the PC to PDA interface is Microsoft ActiveSync. Microsoft ActiveSync provides the capability to “drag” the appropriate PPCEFIS program from the floppy disk on the PC into the proper file directory on the PDA.

The software is designed to work only on PDAs running the PocketPC and PocketPC 2002 operating systems. At the current time all of the Compaq iPAQ series work very well and are the best PDA’s to use for this application. The HP Jornada 560 series also work well with this application.

The PocketPC version is contained in the directory labeled PocketPCARM. To install the software perform the following procedure.

1. Install the software floppy diskette into the PC.
2. Start Microsoft Windows Explorer and browse to the proper directory on the floppy diskette, which contains the PPCEFIS.EXE for your PDA.
3. Connect the PDA to the PC interface and start Microsoft ActiveSync.
4. When the PDA is “connected” to the PC via ActiveSync use the

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“explore” feature of the ActiveSync program to browse to the top directory of the PDA, then browse to the “Windows” folder. You then drag and drop the PPCEFIS.EXE program into the “Start Menu” folder. The “Start Menu” folder is a folder in the “Windows” directory of the PDA.

5. This completes the PPCEFIS.EXE installation procedure.

Software Media

- Provided on 3.5” floppy
- Updates available by download from www.pcflightsystems.com web site
- All specifications subject to change without prior notice.

New software updates are placed on the
www.pcflightsystems.com web site periodically.

The newest software should always be used.

SYSTEM OPERATION

To run the PPCEFIS software do the following:

1. Ensure that no other programs are running on the PDA. The PPCEFIS software requires most of the computing capacity of the PDA device. As a result of this requirement it is important to ensure that no other programs are running during the time the PPCEFIS software is used. If other programs are running the PPCEFIS software may not be able to properly communicate with the IMU module and the graphics display may not function properly. Ensure that the PDA is configured with all “power save” features disabled. This is essential, otherwise the PDA may unexpectedly turn itself off while you are viewing the attitude display. If you need to run other programs on the PDA you must exit the attitude display software using the EXIT button first. You can then use other PDA programs. When you want to again use the attitude display software you must then use the Start menu and again start the PPCEFIS program. DO NOT try to run any other programs on the PDA while the PPCEFIS program is running. Doing so will cause the other programs to run extremely slow and may cause the PDA to run out of memory /CPU resources and “lock up,” causing the need to press the PDA reset button to recover back to normal operation.

2. Ensure the IMU module is securely connected to the serial port of the PDA with a serial interface cable. Serial communication errors will occur if the serial cable connection is not secure. When these errors occur an error message will be displayed on the PDA and the system operation will be halted until the serial data cable is properly secured.

3. Verify that the IMU module is firmly attached to the airframe

4. Apply external power to the IMU module and allow the module to operate for at least 30 seconds before starting the PPCEFIS software.

5. Turn the PDA on and run the PPCEFIS software by selecting it from the “Start” pulldown menu. When the software starts it will perform a calibration procedure which will take approximately 30 seconds to complete.

6. Keep the aircraft straight and level until the software completes the calibration phase. The aircraft should ideally be in a level position on the ground and not moving when the IMU is initially turned on. This is easy to do with tricycle gear aircraft. With tail-wheel aircraft it may be necessary to realign the system while in straight and level flight. This is done by selecting the align button on the PPCEFIS software display. When performing the alignment in the air, it is necessary to hold the aircraft straight and level during the alignment period (approximately 30 seconds).

7. The attitude/horizon should now be displayed on the PDA and the system is ready to use.

8. Upon completion of use of the software use the “EXIT” button at the bottom of the display to end the PPCEFIS.EXE application. You must use the “EXIT” button to end the application and turn the PDA off to keep the battery in the gyro module from discharging. The “EXIT” button is selected by tapping it with the iPAQ stylus.

NOTE: If during flight, the PPCEFIS software is stopped by exiting the program, the system must be realigned when you restart. Keep the aircraft straight and level when you restart the program and hold that attitude until the PCEFIS AI screen reappears. YOU CANNOT PERFORM AN ALIGNMENT UNLESS YOU KNOW THE AIRCRAFT IS STRAIGHT AND LEVEL. YOU CANNOT EASILY PERFORM AN ALIGNMENT WHILE FLYING PARTIAL PANEL IF YOUR MAIN ATTITUDE GYRO IS NOT PRESENTING ACCURATE INFORMATION. WHILE IN IFR CONDITIONS, ALWAYS KEEP THE PCEFIS SYSTEM RUNNING.

RUNNING PCEFIS WITH OTHER SOFTWARE (NO REALIGNMENT REQUIRED WHEN RESTARTING PCEFIS)

The PCEFIS software starting with version 2.7a and above, can run in the background while other applications are running on the screen. This means that the PCEFIS software continues to calculate the aircraft's attitude, while other applications are using the rest of the PDA and the screen. No alignment is required when PCEFIS is restarted when it has been running in the background.

For example, you may want to run the GPS map on the screen while the PCEFIS software is running in the background. However, in order for the PCEFIS software to get its data from the gyro at the same time the map program is getting GPS data, your iPAQ must have TWO serial ports. One port is built in on the bottom of the iPAQ and the second port is implemented using a Compact Flash Card sleeve and a plug-in CF card serial port. Contact Pcfightsystems about purchasing the required extra hardware to implement the second serial port.

For optimum performance when used with a GPS map, configure the GPS map for "Slow Updates". This will not affect the GPS map's operation and will ensure that the PCEFIS software will be able to calculate the aircraft's altitude accurately.

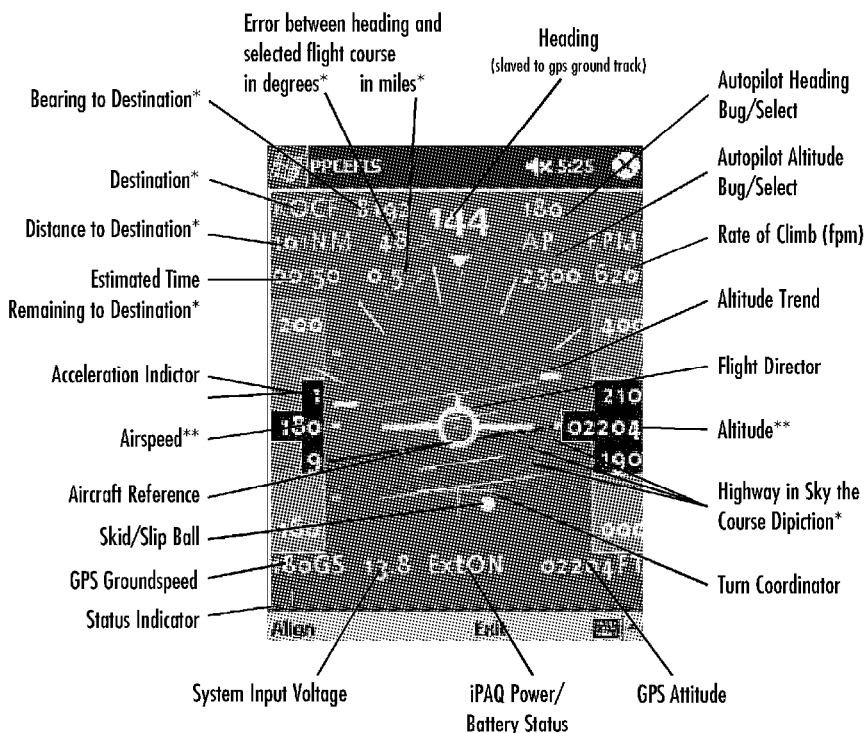
To allow easy toggling between two applications such as the PCEFIS and the GPS map, you must assign these applications to the buttons on the front of the iPAQ. This is easily done by the following process:

Select "Settings" from the main menu. Then select "Buttons". Now select which of the four buttons you want to use for PCEFIS. Then select the arrow on the box below the button selection. Select Star Menu and then the PCEFIS. Finish by touching the OK at the top right of screen. Now the selected button will start the PCEFIS

application. Repeat this process for the GPS map or any other application that you want to toggle with PCEFIS. You will have to locate this application where it now resides on your iPAQ after selecting the button which will activate it.

Start PCEFIS using its new application button. Align the gyro as described above and then activate the map program of your choice. The map program will take over the screen. To reactivate PCEFIS, press its' button. When in actual IFR conditions, it is recommended that you keep the PCEFIS display running on your iPAQ.

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*Requires use of a GPS with a destination waypoint selected.

**Pressure Airspeed and Altitude provided when optional airdata interface is used, otherwise the "tapes" display GPS groundspeed and GPS Altitude when a GPS is connected.

Select/Deselect "HITS" mode by pressing the iPAQ "top hat" switch in the center. When in HITS mode "top hat" switch controls autopilot target altitude and heading. When not in HITS mode "top hat" switch is used to control pitch reference "zero" setting. This allows pitch "zero" to be easily manually adjusted for different aircraft trim conditions.

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SYSTEM FUNCTIONAL DESCRIPTION

The PPCEFIS software performs two major functions which include digital signal processing of the IMU data and the processing required to graphically display the attitude/artificial horizon data.

The PPCEFIS software performs approximately one half of the digital signal processing of the IMU sensor data. This allows the signal processing algorithms to be easily enhanced in the future, by simply installing an updated PPCEFIS.EXE program onto the PDA. INS signal processing techniques are rapidly evolving and new techniques are continuously being developed. Allowing the PDA to perform a portion of the digital signal processing allows these new techniques to be implemented in the future, without the need to update the IMU module. This prevents the IMU module from becoming obsolete as new signal processing techniques become available.

The PPCEFIS software performs all of the graphical display capability of the system. This allows new display techniques to be added in the future by installing an updated PPCEFIS.EXE program onto the PDA. This further allows the system to remain "state-of-the-art" through software upgrades.

New PPCEFIS display capabilities are continuously being developed. At the current time the PPCEFIS contains several different types of data displays, all of which are simultaneously displayed.

The primary display is the Attitude/Artificial Horizon display. This display is an EFIS attitude display and looks much like a conventional attitude/artificial horizon gyro display. Pitch is denoted with a scale which has a minor divisions at ± 5 degrees of pitch and major divisions at ± 10 degrees of pitch. A roll display scale is also provided which has minor divisions at ± 10 and 20 degrees of roll and major divisions at ± 30 and ± 100 degrees of roll. A roll angle pointer is located at the top of the attitude display. This roll angle pointer is an inverted white triangle. The roll angle pointer is called the "triangle reference pointer" The roll angle can be read from the scale marking directly below this roll angle pointer.

The display also simultaneously contains a turn coordinator display. This display is at the bottom center of the display and is located at the top of a small vertical line (this line is the skid/yaw reference line for the ball indicator). The turn coordinator display consists of a turn rate indicator line (which is a horizontal line which tilts to depict turn rate - the same as a turn coordinator) and a slip/skid ball indicator. The turn rate indicator line depicts the rate of turn of the aircraft and is useful to keep the aircraft heading stable. The slip/skid ball indicator depicts slip and skid information in exactly the same manner as the classic ball slip/skid indicator.

There are several other types of information depicted on the PDA display. This information includes a linear acceleration indicator. The linear acceleration indicator is a small horizontal bar that is positioned on the left side of the display. This pointer depicts the type of acceleration on the pitch axis of the aircraft. If the bar moves upward the pitch acceleration is toward an upward bias. If the bar moves downward, the pitch acceleration is toward a downward bias. During a climb the bar will move upward and during a descent the bar will move downward. The bar will also move when the aircraft is accelerating or decelerating, this can be useful to evaluate the aircraft acceleration during the take-off roll, and the level of braking effectiveness after touchdown on the runway. During normal straight and level flight this bar should be located at the center reference marker and the slip/skid indicator should be centered at it's reference line. If these conditions do not exist, then this indicates that the IMU and PPCEFIS software are not properly calibrated. This means that the "Align" function should be run during straight and level flight to allow the system to recalibrate. You can also adjust the pitch reference, without using the "Align" by using the "top hat" button located at the bottom of the iPAQ. Pressing the upper part of the top hat button will move the pitch reference upward, pressing the bottom part of the top hat button will move the pitch reference downward. This allows a convenient way to adjust the pitch "zero" setting at any-time. It can also be used on the ground to properly set the pitch attitude reference for tailwheel aircraft.

An activity status indicator is provided at the bottom left of the display. This activity indicator should always be flipping from ver-

tical to horizontal. This indicates that the iPAQ and PCEFIS system are both functioning. If the activity indicator is not “flipping” then the system is NOT WORKING and must not be used for any purpose - check all connections, power supplies, and reset the iPAQ (using the reset button) before continuing to use the PCEFIS if the activity indicator ever stops “flipping”.

The PDA displays a power supply system input voltage level indicator as a text readout at the bottom of the display. When running on external power this will display the aircraft system voltage, when running on internal battery it displays the internal battery voltage. When the power supply/battery reaches 7 volts the IMU will no longer operate properly so the system will automatically stop functioning and display a low battery voltage error display. The battery must be replaced, or the IMU must be connected to a power source having a voltage of 8 to 32 volts to continue operation. After this is done, the “align” function must be run to ensure that the system is properly calibrated.

Next to the system input voltage display is a status display for the iPAQ power. When the iPAQ is running from external power this will display “ExtON”. When the iPAQ is running from its internal batteries the unit will display the approximate amount of battery life remaining - such as “90%iB” which indicates that the iPAQ has approximately 90% battery life remaining. Note that the iPAQ may automatically turn itself off it reaches around 50%iB. If the iPAQ ever turns itself off you must run the “Align” function before using the PCEFIS, otherwise the display will not be correct. The iPAQ power status will display “IBat?” if external power is lost and the software can’t determine the amount of remaining battery power. For normal usage the iPAQ status should always be “ExtON” . If “ExtON” is not displayed then you have either lost aircraft electrical power, or the PCEFIS system has become disconnected from the aircraft supply. In either event action must be taken or you will lose PCEFIS functionality when the iPAQ battery becomes discharged.

HIGHWAY IN THE SKY MODE

The gyromodule has a connector which can be connected to any standard GPS serial output (NMEA 4800 baud). This connector is the bottom connector on the gyro module. Pin 2 of the connector must be connected to an NMEA 4800 baud data signal and pin 5 must be connected to the GPS unit ground. When the GPS is connected, and at least 4 satellites are received, the system will automatically display the additional GPS derived data. The data will not appear if there is no valid GPS data being received. When valid GPS data is available the AHRS option provides the following additional information onto the EFIS display:

Directional Gyro Heading slaved to GPS Ground Track - at the top of the display.

Rate of Climb - digital readout, in feet per minute, at top right of display and an altitude trend bar located on the right side of the display.

Altitude "TAPE display" - at the right side of the display. This will show GPS altitude unless the optional airdata interface is used.

Ground Speed "TAPE display" - at the left side of the display. This will show GPS ground speed unless the optional airdata interface is used.

If a waypoint has been selected in the GPS then the following information will be also displayed on the PDA screen:

Destination waypoint Identifier - This is located in the top left of the screen and is the identifier of the waypoint you are currently configured to navigate to.

Distance to designation - this is the distance to the currently selected waypoint in Nautical Miles.

Bearing to Destination - This is the current bearing (compass direction) to the destination .

Heading/course error in degrees - this is the difference between your current heading and the course between your origin waypoint and your destination waypoint.

Heading/course error in miles- this is the distance in nautical miles the selected course is from your current position.

Estimated time remaining to the destination - This displays the estimated amount of time remaining until you reach the selected waypoint.

Course indicator circle - this is a purple circle which depicts the location of the selected course, relative to the aircraft.

HIGHWAY IN THE SKY MODE

NOTE: NONE OF THE PCEFIS FUNCTIONS ARE INTENDED FOR PRIMARY AIRCRAFT CONTROL FUNCTIONS. THEY ARE TO BE USED ONLY AS BACKUP INDICATORS - NEVER USE ANY OF THE PCEFIS DISPLAYS AS PRIMARY AIRCRAFT CONTROL INDICATORS. THIS IS ESPECIALLY TRUE WITH THE HIGHWAY IN THE SKY MODE OF OPERATION!!

The “Highway In The Sky” (HITS) mode is selected by pressing the center of the “top hat” button of the iPAQ. This mode requires that a GPS destination waypoint is selected. When the HITS mode is selected there are three new major items displayed on the screen. The HITS course depiction, a flight director, and an autopilot heading/altitude selection.

The HITS course is depicted by three purple circles. These circles represent the desired flight path. The intent is to keep the aircraft flying through the center of the circles.

The Flight Director is a purple triangle which can be thought of as a “lead aircraft”. The intent is to follow this “lead” aircraft to remain on course. IMPORTANT NOTE - THE FLIGHT DIRECTOR

IS ONLY A GENERAL GUIDELINE - NEVER USE IT AS A PRIMARY FLIGHT INSTRUMENT - IT WILL PROVIDE ROLL AND PITCH COMMANDS WHICH MANY AIRCRAFT ARE UNABLE TO FLY - NEVER, EVER, RELY ON THE Flight Director to control your aircraft.

The autopilot functions are provided to enable you to set a “heading bug”(or autopilot target heading) and “altitude bug” (or autopilot target altitude) . The “altitude bug” is used as also use as the altitude target for the Flight Director. The flight director will prompt you to fly the aircraft to this target altitude. A future autopilot option will use these values to control the target altitude and heading for an optional autopilot module.

To adjust the heading and altitude target values, use the “top hat” button. Pressing the top of the button increments the altitude target value, pressing the bottom of the button decrements the altitude target value. Pressing the left side of the button decrements the heading target value. Pressing the right side of the button increments the heading target value.

GPS INTERFACE CABLES

The GPS connector requires only two wires. The GPS data ground line should be connected to pin 5 of the GPS connector. The GPS data signal line should be connected to pin 2 of the GPS connector. A custom cable (GPSIFCAB-2) is available which provides a connector with a short interface wire connected to it. The black wire of the GPSIFCAB-2 should be connected to the GPS unit. The load is small and this cable can be “T” connected to existing GPS systems, even if they are driving other devices. To connect the GPSIFCAB-2 connect the black wire to the GPS ground line and the white wire to the GPS signal wire. The GPS must be set to run in the 4800 Baud NMEA mode.

There are also several custom data interface modules available to allow integration or the PCEFIS system with engine monitors and other options.

Please refer to the custom interface module documentation for these options.

Connecting the GPSIFCAB-2 to a Garmin GPS35 unit

The GPS35 receiver has a single wire running from the antenna/gps receiver. The other end of this wire is connected to either a DB-9 connector or an integration module and/or power supply. If the unit contains a DB-9 connector simply connect the GPSIFCAB-2 black wire to pin 5 of the connector and connect the white wire to pin 2 of the connector. If the GPS35 is wired directly into an integration and/or power module of some sort (e.g. Controlvision Anywheremap) then you will need to open the integration/power module so you can access the wires connecting to the GPS35. The wires which you must connect to are the black and white wires coming from the GPS35. Connect the black wire of the GPSIFCAB-2 to the black wire from the GPS-35, and connect the white wire of the GPSIFCAB-2 to the white wire of the GPS-35. Note that the GPS35wires can remain connected to other circuits, as the gyro module does not apply any significant load to the GPS35. This allows the GPS35 to drive other devices, in addition to the gyro module.

CABLE OPTIONS TO CONNECT GPS RECEIVERS

GARG Cable for Garmin receivers with 4 pin round connector (Pilot III,

PCFlight Systems

295, and others). Connects GPS to IMU for both GPS power and data. Eliminates need to use cigarette lighter power cable for GPS.

GAR195 Cable for Garmin 195. Connects GPS to IMU for both GPS power and data. Eliminates need to use cigarette lighter power cable for GPS.

GPSSC Smart Cable for panel mounted GPS receivers. Converts aviation format to NMEA format using a microprocessor located inside the cable connector. Allows any Garmin, King, UPS, or Trimble panel mounted GPS receiver to drive the heading and GPS features of the PCEFIS. Requires that a jack be mounted on the instrument panel and connected to your GPS's serial output. This jack and mating plug are not supplied. The red wire goes to GPS receiver output and black and shield are grounded at the jack.

TROUBLESHOOTING

This section discusses some solutions to the problems you may encounter when operating the attitude display system.

It is recommended that you become familiar with the system, and initially use the system, before trying to use it in an aircraft. The system can be operated sitting on a table and moved by hand. All you need to do is power up the system per the procedures while the IMU is setting on a flat surface. Keep in mind that when the IMU is moved by hand, you can easily exceed the 100 degree per second maximum angular rate limit. This will not damage the unit, but will cause loss of calibration and the unit will then temporarily display an incorrect attitude. Setting the unit on a flat surface will allow the unit to automatically recalibrate after a period of a couple of minutes. The unit will also automatically recalibrate while the aircraft is maintained in straight and level flight over a period of a few minutes. You can also realign the unit by pressing the Align button on the display, while the unit is setting on a flat surface, or while the aircraft is in straight and level flight. The unit will continue to operate though an inverted position (and even rolls), although it is not intended to be used for aerobatic type maneuvers and will not be accurate when inverted.

If attitude display does not appear on the PDA display:

This problem is most likely caused because the PDA is not receiving data from the IMU. Upon initial startup of the software a calibration procedure is automatically performed before the attitude display appears. This calibration procedure can take up to 30 seconds. If the attitude display does not appear within about 30 seconds then this indicates that the PDA is not receiving data from the IMU. Ensure a fresh battery and/or good power source is connected to the IMU. Ensure the IMU external power is turned on. Ensure that the serial cable is securely connected between the IMU and PDA. Ensure that the PDA is not running some other software. It is especially important to ensure that the PDA is not running software which also uses the serial port (such as a GPS software moving map). Some software packages use the serial port and do

not properly close the serial port. This can cause the serial port to become inoperative until the PDA is reset. A reset of the PDA will generally cause the serial port to start working again and should allow the attitude display software to be able to access the serial port properly. It is also important to ensure that the PPCEFIS.EXE application is stopped by selecting the "exit" menu item, before turning the PDA off. Failure to follow this precaution can cause the PDA serial port to stop operating properly until the PDA is reset.

In almost all cases, replacing the battery in the Gyro module and pressing the PDA reset button will resolve a problem where the attitude display does not appear. The PDA reset button is on the bottom of the iPAQ and can be pressed using the stylus.

If attitude display becomes blank:

The attitude display software will automatically blank the display in the event that the power supply/battery voltage drops below 7 volts. The attitude display software will also automatically blank the display if the serial communications with the IMU becomes marginal. If the attitude display becomes blank, ensure that the IMU power supply/battery is adequate, ensure that the serial cable is firmly connected, and ensure that the IMU has not been inadvertently turned off. If the attitude display becomes blank, it is recommended that the align procedure be performed prior to again using the attitude display information.

If attitude display is not accurate:

The most probable cause of this problem are the following:

IMU is not mounted in a level position.

Align procedure was not performed with IMU in level position.

IMU is vibrating.

IMU is moving on it's mount.

100 degree/second angular rate has been exceeded.

After confirming that all of the above problems are addressed, you should perform the Align function while holding the aircraft in a straight and level flight attitude.

If PDA display turns off:

The PDA batteries/power source have become inadequate. Restore the power supply with recharged batteries or reconnect the power source if this occurs. You will then have to run the Align procedure.

The PDA is configured into some “power save” mode and has powered itself off. In this event you must reconfigure the PDA to disable all “power save” modes. Turn the PDA back on and run the Align procedure.

If the PDA loses the program:

The PDA requires the internal batteries to contain charge in order to retain internal programs. Do not allow the PDA internal batteries to become discharged. The PDA should always be kept on the charger whenever not being used for more than two weeks. Failure to keep the batteries charged will cause the PDA to lose the program. If this occurs recharge the PDA and reload the software into the PDA , then ensure the PDA is kept on the charger when not in use.

If the PDA Display is slow or sluggish:

The PPCEFIS software requires the full processing power of the PDA. If the PDA screen is slow to update then this indicates that other programs or tasks are running on the PDA. It is possible to have many “hidden” programs running on the PDA which can’t be viewed by any of the “status” software programs. The only way to ensure that no programs are running is to use the PDA reset button. In the Compaq iPAQ this button is located behind a small hole on the bottom right side of the iPAQ. The button must be pressed by inserting the tip of the Stylus through this hole and ensuring that the button is pressed. The PDA will then indicate that it has been reset and will start up. You can then run the PPCEFIS software.

Note that pressing this reset button will not cause you to lose any programs that have been loaded onto the iPAQ. The reset button

will only ensure that no programs are actively running in memory. This is the only method which can be reliably used to make sure no programs are running in active memory. It is recommended that the reset button be pressed prior to each use of the PPCEFIS program.

In most cases we have noticed that even brand new iPAQs have some background programs running in active memory. This causes the PPCEFIS program to update the display very slowly. To eliminate this problem always press the iPAQ reset button prior to the first time you run the PPCEFIS program.

EFIS-AIGYRO6X IMU MODULE SPECIFICATIONS

Physical Enclosure

Dimensions

6.75" x 4.75" x 2.5"

Weight

16 oz.

Power Supply

Battery

Standard 9 Volt Battery

External Power (if battery is not used)

8 to 32 Volts @ less than 50 ma.

External Interface

RS232 DB9 Male Connector

Pinouts for upper connector (to PDA)

1. No Connection
2. RX Data (from PDA)
3. TX Data (to PDA)
4. +5 volt out (to PDA)
5. Ground
6. CTS Input (from PDA)
7. No connection
8. RTS (From PDA)
9. RX Data from GPS connector (mirrors pin 2 of lower connector)

Pinouts of Lower connector (to GPS source)

1. 3.3 vdc out to power GPS
2. RX Data from GPS
3. No connection

4. +5 volt out to power GPS
5. Ground
6. No connection
7. No connection
8. No connector
9. Aircraft power out (to power portable GPS receivers) is connected to the DC input jack

Method of Attachment to Airframe

Velcro

Must be aligned parallel to the aircraft longitudinal axis

Data Output

RS232 Serial

115.2 Kbaud

Data update rate

greater than 50 per second

Sensor Specifications

Startup time

Less than 1 minute

Max roll and pitch rate

100 degrees per second

Drift (maximum average drift over 8 hours)

Pitch and Roll +/- 5 deg

(in level attitude)

Environmental

Operating Temp Range

-30 to +75 C

Storage Temp

-40 to +90 C

MTBF

50,000 hours

EFIS-AISW3 SOFTWARE SPECIFICATIONS

Compatible PocketPC computers/serial cables

Compaq iPAQ series handheld computer (PDA)
The recommended PDA is the Compaq iPAQ series or faster
Slower PDA's generally have screen refresh rates approximately
1/10th that of the iPAQ series.

Display

Artificial Horizon Display
 Simultaneous display of pitch and roll attitude
Turn Rate Indicator
Slip/Skid Indicator
Gyro Heading slaved to GPS ground Track (requires gps option)
Altitude MSL (requires gps)
Altitude Trend (requires gps)
Rate of Climb (requires gps)
Ground Speed (requires gps)
Ground Speed Trend (requires gps)
Power Supply Voltage Indicator
Pitch Acceleration Indicator
Refresh Rate approx 10 times/sec (depending on PDA model used)

User Controls

Align Button
 Performs "caging" calibration function to reset display to level
Exit
 Exits PPCEFIS program

SERIAL INTERFACE PROTOCOL

The following describes the serial interface protocol used for the standard product. This format can be changed with no prior notice to enable the addition of new product features.

Baud Rate

115.2 Kbaud

Message frame rate

> 50 Hz

Data Frame Byte Sequence

Byte No.	Description
0	Synch Char value = 0x01
1	Synch Char value = 0x00
2	Roll Rate LSB
3	Roll Rate MSB
4	Pitch Rate LSB
5	Pitch Rate MSB
6	Yaw Rate LSB
7	Yaw Rate MSB
8	Accelerometer Reference LSB
9	Accelerometer Reference MSB
10	Longitudinal Acceleration LSB
11	Longitudinal Acceleration MSB
12	Lateral Acceleration LSB
13	Lateral Acceleration MSB
14	Yaw Axis Acceleration LSB
15	Yaw Axis Acceleration MSB
16	Power Supply Voltage
17	Checksum